2009

Effects of an Informal Science Program on the Perceptions of 4-6th Grade Minority Girls toward Science and STEM Careers

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This research paper is presented to the Graduate Faculty of the
Department of Occupational and Technical Studies at Old Dominion University

In Partial Fulfillment of the
Requirement for the Degree of Master of Science in Occupational and Technical Studies
Business and Industry Concentration

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October 2009

ABSTRACT

This study examines eleven minority girls' enthusiasm, confidence, ability and interest in Science, Mathematics, Engineering, and Technology (STEM) careers through a community-based, informal science program. The eleven girls who participated consisted of five in fourth grade, three in fifth grade, and three in sixth grade. All of the girls participating in the program were from low-income families and attended public schools in Richmond, Virginia, and the surrounding counties of Henrico and Chesterfield. The program was offered as a week-long, mini-camp session at a neighborhood community center. Data collected and analyzed showed that the program had a positive effect on the girls. The participants' confidence, ability, and interest in science and STEM careers increased after participation in the program.

APPROVAL PAGE

This paper was prepared by Angel Thomas under the direction of Dr. John M. Ritz as a part of OTED 636, Problems in Occupational and Technical Studies. It was submitted to the Graduate Program Director as partial fulfillment for the degree of Master of Science in Occupational and Technical Studies with a concentration in business and industry training at Old Dominion University.

APPROVAL BY:_____ DATE:_____

Dr. John M. Ritz

Advisor and Graduate Program Director

ACKNOWLEDGEMENTS

Thank you to the Salvation Army Boys and Girls Club staff who gave me the opportunity to conduct this study at their facility and work with their students. A special thanks to my former and current colleagues at the Science Museum of Virginia for their support. Thank you to Dr. Ritz for his guidance in the completion of this thesis.

-Angel Thomas

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CHAPTER I

INTRODUCTION

Science, Technology, Engineering, and Mathematics (STEM) careers are the fastest growing of the 21st century. Even so, few minority females choose these career paths according to National Academies Press report on *Rising Above the Gathering Storm* (2007) and the Council on Competitiveness *Innovate America* report (Education News.Org, 2007). In 2007, it was reported by the National Science Foundation that there were 4.9 million science and engineering workers. African-American females represented only 2% of that population. In comparison, Caucasian females comprised 20% of the same population. This statistical information indicated an underrepresentation of African-American females in STEM occupations.

What is the underlying cause of the fact that African-American females are not choosing STEM careers? Do their early science experiences have a lasting effect on their future attitudes toward science? Do they carry a negative attitude about science? Do they think that science is boring? Do they feel that science is too difficult for them to understand? Do they feel that they are not smart enough to have a STEM career? Do they think STEM careers are only for men or any race other than themselves? Are they even aware of careers in STEM? These may be questions that are pondered by researchers when they are trying to discover why minorities and/or females do not choose STEM careers. Research studies have been conducted to find "best practices" for mentoring minorities and/or females in STEM education.

The Girls-Building Leaders and Science Technologists (Girls-BLAST) program was designed for this research study to become an early intervention program which

would inspire African-American girls to adopt a positive attitude about science and STEM careers through hands-on learning activities. The program was presented using best practices from other research studies that used experiential learning activities in informal settings.

Statement of the Problem

The problem of this study was to determine whether participation in an informal STEM program would positively influence the perceptions of African-American girls in grades 4-6 about science.

Research Goals

The goals of this study were to answer the following questions:

1. Will the girls' enthusiasm toward science increase if they participate in informal science lessons in a non-school setting?

2. Will the girls' confidence and ability toward science increase if they participate in informal science lessons in a non-school setting?

3. Will the girls have an interest in pursuing STEM careers if they participate in informal science lessons in a non-school setting?

Background and Significance

Researchers have discovered a number of potential reasons why the number of African-American and minority females in STEM careers is not increasing. A lack of quality in early educational STEM experiences, a student's socio-economic background, a lack of female minority role models in STEM career fields, and a lack of mentoring

support for STEM education are potential factors which may have a direct or indirect influence on the final career choice of women (Fadigan & Hammrich, 2004).

African-American female students' interest in STEM education and careers should be nurtured. At an early age, an opportunity to explore STEM education and careers should be available for them to participate in and discuss. This opportunity should begin as early as primary school. Researchers discovered that primary school and secondary school experiences can influence how girls perceive science in their current and future lives (Jenks & Kahlon, 2005). It is in these early school experiences, where girls initially develop an awareness of gender differences, that their confidence, ability, and interest in STEM education and/or careers should be focused.

This research study set out to provide early intervention STEM activities which were designed to build a strong foundation in STEM education for African-American girls. The desired outcome is that the participants will become confident in science, technology, engineering, and mathematics. African-American females make up only 2% of the United States STEM workforce. If positively impacted by their early STEM education, girls will develop into young women who will feel interested and enthusiastic about mathematics and science and possibly pursue STEM careers. The results of this study may reinforce the necessity of good early mathematics and science teaching in order to increase the participation of African-American girls in STEM careers.

Limitations

The girls who participated in this program were in grades 4-6. All of them were from low-income families and attended public schools in Richmond, Virginia, and surrounding counties of Henrico and Chesterfield. The program took place for four

hours a day at a local neighborhood Salvation Army Boys and Girls Club during the summer. This study measured only the immediate impact of the program on girls' attitudes toward science. The girls were not tracked through high school and/or college. It is not known what their career choices will be.

The study was limited in that all activities were presented informally and involved hands-on activities. The activities focused on topics of toy design, food technology, and theme park engineering.

Assumptions

The researcher assumed that if there is an increase in the girls' enthusiasm and confidence in science, the probability of their pursuing STEM careers would also increase. This study also assumed that a successful program would have the following characteristics:

- an informal setting
- involves experiential learning
- contains educational content that is relevant and could be applied to students' lives (real-life application)
- has a female role model
- provides activities that are hands-on.

Procedures

This research study focused on the girls' enthusiasm, confidence, ability, and interest in STEM careers before and after participation in the Girls-BLAST program. A pre-test was administered to the girls before the program began and a post-test was administered after the activities were completed. Data obtained from the pre- and post-

tests were analyzed and compared by the researcher to determine if there were significant differences in the girls' enthusiasm, confidence, ability, and interest in STEM careers due to their participation in the program.

Definition of Terms

The following terms are defined to explain their meaning in this research study:

1) Informal Science Education: The National Science Foundation (2001) states that informal science education "provides rich and stimulating experiences outside of the formal classroom setting. Exhibits at museums, aquaria, zoos, IMAX films, television, and community programs help to increase appreciation, interest, and understanding of science of individuals of all ages, interests and backgrounds" (p. 41).
2) Hands-On Science: science that involves tactile, visual, and kinesthetic learning.
3) Scientific Inquiry: the diverse ways in which scientists study the natural world and propose explanations based on evidence derived from their work; it also refers to the activities of students in which they develop knowledge and understanding of how scientists study the natural world (National Science Education Standards, 2007). Inquiry is the opposite of the authoritative-expert model of instruction.
4) STEM: an acronym for Science, Technology, Engineering, and Mathematics.

Overview of Chapters

Chapter I established the need for providing STEM educational program opportunities for young African-American girls. African-American women still are outnumbered in pursuing and obtaining professional STEM careers by men and

Caucasian and Asian women. Early intervention has been suggested by researchers as a solution to encourage minority girls to have an interest in STEM education and careers. Intervention may come in the form of specialized programming for girls in their primary and secondary school years. This study provided STEM intervention programming for African-American girls in grades 4-6.

Chapter II will examine research evidence that exposes the gap in achievement, progress, and attitudes of minorities and females in science. Chapter III will explain the procedures implemented in this study. Chapter IV and V will present the results of this research study, make conclusions, and project recommendations for revision or continuation of the study.

CHAPTER II

REVIEW OF LITERATURE

Supporting evidence that provided the foundation for this research study involved reviewing and selecting relevant literature regarding statistical reports on STEM occupational outlooks, STEM occupational statistics for females and minorities, research regarding possible causes of minorities and females not choosing STEM careers, former research tips on how to design and implement early STEM intervention programs for minority females, and examples of best practices for STEM education with girls and/or minority students.

Statistical Report on Women and Minorities in STEM Occupations

In 2007, the American Competes Act by the United States Senate reported that the United States is not producing enough United States citizens who pursue STEM careers (Education News.Org, 2007). Thus, the United States is not competitive in these professional career fields when compared to other nations. To increase the number of United States STEM professionals, it was suggested that "educational opportunities in science, technology, engineering, and mathematics from elementary through graduate school must increase" (Education News.Org, 2007). Statistical information from the National Science Foundation in 2007 indicated that out of 4.9 million STEM workers employed in the United States, African-American women only make up 2% of that number.

Causes of Underrepresentation of Minority Women in STEM

The research work of Welde, Laursen, and Thiry (2007) suggested that the

underrepresentation of women in STEM careers may be explained throughout all the stages of life. During the early school years girls are overlooked and given less attention than boys. They lack role models, they lack emotional and academic support in STEM subjects, they face gender discrimination in the hiring process, they do not receive equitable salaries compared to their male counterparts, and they face greater challenges balancing home and work life.

Researchers Jenks and Kahlon (2005) list three main causes of the underrepresentation of minorities and females in STEM careers (p. 8):

1) People of color have less access to high-quality pre-K-12 mathematics and science education, one of the strongest factors affecting future achievement.

2) Fewer opportunities for girls in STEM-related extracurricular activities at the pre-K-12 level create achievement gaps between boys and girls.

3) The underrepresentation of women and people of color in STEM fields means that few role models are available, and women and people of color are rarely portrayed as participating in STEM careers.

Research Tips on Designing STEM Programs for Girls

When a STEM program is designed for girls in general, it must be designed to appeal to, engage, and address the needs of the girls involved. According to the research work of Campbell (1992), STEM programs that target girls should be fun, out-of-school experiences that include "lots of hands-on activities" and opportunities for career and program discussion. Hands-on activities should empower them because "the act of doing science" will increase girls' confidence and attitude about their ability in science and

mathematics (Hammrich, 1997). In addition to the implementation of hands-on activities, successful programs for girls should "include fostering a safe and nurturing environment, promoting problem solving skills, creating collaborative experiences …and allowing for open discussion about gender types (Hammrich, 1997). In order for a young girls' program to be effective, it must involve the following styles of teaching: constructivist, experiential, and inquiry-based. Constructivist teaching styles will encourage students' retention by interacting with their environment to create mental maps of what they are learning. Experiential teaching styles will incorporate student experiences (past and present) to influence their motivations for learning. Inquiry-based teaching styles will encourage students to think about and research their own answers to questions.

The learning environments where STEM activities for minority girls take place should be carefully chosen so that they do not replicate formal classrooms. Learning environments for these STEM activities should be in informal settings and offered during non-school hours. Basu and Barton (2007) believed that a "sustained interest in science…is not always cultivated in traditional venues like school science" (p. 466). Examples of informal settings may be after-school programs, Saturday science programs, or science camp programs.

The program should provide role models. Females and minority STEM role models are still rarely seen in today's textbooks, television, or other features in the media (Moffet, 1992). Hammrich (1997) says that "females tend to view the field of science and mathematics as a male domain, often leading to the reluctance of girls to go into science and/or mathematics as a field of study or career" (p. 6). Minority girls, like all students, need someone that they can identify with and that inspires them to reach for the

same goals. According to Axelson (1996), "If students don't see images of themselves—people who look like them or who come from similar backgrounds—they can't connect easily. Role models are a hugely important thing" (Administrator Magazine, ¶ 4).

Examples of Programs with Best Practices

Searching for best practices to implement the Girls-BLAST program for the African-American girls in Richmond, Virginia, the researcher reviewed the research work of STEM programs for minority girls that had a positive impact on attitudes, confidence, ability in science, and/or their interest in STEM careers. Research studies that had a positive impact included the *Sisters in Science* program in Philadelphia (Hammrich, 2000), *Project SPLASH* in Seattle, Washington (Murphy & Sullivan, 2000), and *Rural and Urban Images: Voices of Girls in Science, Mathematics and Technology* in Charleston, West Virginia (Kusimo, 1997). Each of these projects shared a common theme of empowering minority females in science, mathematics, engineering, and/or technology education. *Sisters in Science* (2000) provided a positive learning environment for minority girls to learn and resulted in a "positive pattern of change in the females' process and language skills" (p. 2). *Project SPLASH* (2000) techniques of encouraging minority females was to discover and address minority girls' perceptions of the mathematics and science program, gender issues, girls' self-esteem, and motivation. Kusimo's *Voices* (2000) project focused on how the at-risk factors of minority girls affected their confidence and career aspirations while they participated in their three year project. At-risk factors included gender, race, low socio-economic backgrounds, home and neighborhood life, and perceptions of themselves. Results from these studies

discovered that for minority girls to succeed in science and mathematics, they must have a realization and resiliency to the factors that would stop them from being successful.

Summary

Women and minorities are still underrepresented in STEM occupations in the United States with African-American women comprising the lowest percentage of the STEM workforce. Researchers attributed this underrepresentation to a lack of quality education, poor socio-economic background, lack of female minority role models, lack of gender equity, and lack of emotional support. Early intervention during the primary and secondary school years may be the solution to increasing the number of African-American women in STEM careers. Specialized research programs like *Sisters in Science, Project Splash,* and *Voices* had a positive impact on minority girls' perceptions, abilities, and interests in STEM education. The girls-BLAST research set out to be an integral partner in helping to close the gaps in gender, equality, and socio-economic backgrounds which hindered African-American girls in STEM education and careers by providing and monitoring selected informal science activities. Chapter III will describe the methods and procedures implemented in this study.

CHAPTER III

METHODS AND PROCEDURES

The focus of this research study was to determine if low-income minority girls could be encouraged to consider a STEM career after participating in an informal science program outside of school. Chapter III will describe how the attitudes, confidence levels, and ability of the girls before and after participation in the informal science program varied. The data were evaluated through statistical analysis to determine the significance of the study.

Population

The population consisted of eleven African-American girls, five in fourth grade, three in fifth grade, and three in sixth grade. All the girls attended a public school system in Richmond, Virginia, or the surrounding counties of Henrico and Chesterfield. The girls were all members of the Salvation Army Boys & Girls Club where the study took place.

Research Variables

The dependent variables in this study were the girls' enthusiasm for science, their confidence in science, their ability in science, and their interest in STEM careers. The independent variable in this study was the method of presentation of science lessons in a non-school setting. These included hands-on learning activities in toy design, food technology, and theme park engineering. It was assumed that exposure to informal science lessons would increase girls' enthusiasm for learning science, their confidence in science, their ability in science, and their interest in STEM careers. The before and after

survey question responses helped to guide the effectiveness of the variables used in this study.

Instrument Design

The instrument used in this study consisted of fourteen pre- and post-program survey questions. Survey statements remained the same in the pre- and post-survey. A five-point Likert scale was used for girls to rate their response to each survey question. Response rating options for girls to select from were 5 for strongly agree, 4 for agree, 3 for undecided, 2 for disagree, and 1 for strongly disagree. The use of a Likert scale to measure attitudes in research studies has proven to be a valid and reliable method of choice for similar research studies (Murphy & Sullivan, 1997). At the end of both pre- and post-program surveys, the girls were asked to complete two open-ended statements which allowed the researcher to capture participants' opinions of the program in their own words, not the words of the researcher. Pre- and post-surveys were designed to be administered in paper and pencil format. The pre-survey used in this study can be found in Appendix A. The post-survey can be found in Appendix B.

Program Procedures

Each Girls-BLAST lesson began with the girls being introduced to a STEM career that was followed with hands-on activities and/or an inquiry-based project. The girls worked in small cooperative learning groups to explore, experience, discover, and discuss activities and projects. The curriculum included toy design, food technology, and theme park engineering. In the toys design lesson, girls took apart various toys to see how they worked and discovered that electrical circuits make the nose light up and buzzer sound in the Operation game. They then designed their own toy for marketing. The girls

experimented with their own formulas for making ice-cream and cola in the Food Technology lesson. The Girls-BLAST program ended with the Theme Park engineering lesson, having the girls build a rollercoaster design of their own. For information regarding the curriculum schedule used in this study, please see Appendix C.

Methods of Data Collection

Data from in this study were collected after receiving a permission form from each girls' parent/guardian. Individual girls' assent forms were collected to make them aware that their participation was completely voluntary and they could discontinue the program at anytime.

Pre- and post-surveys were administered to the participants by a Salvation Army Boys & Girls Club staff member to avoid bias responses by the girls to the researcher's survey statements. They were allowed 10 minutes to complete the survey. To maintain the confidentiality of the BLAST girls, each girl was asked not to write their names on the survey. Instead they were given a code ID that relates to science (i.e., Nebula, Star).

Statistical Analysis

Participant responses before and after the program were compared and analyzed using descriptive statistics (number, frequency, and mean). This method of statistics was important in determining if there was any significant change in the way the girls responded to the program survey before and after the program.

Summary

Chapter III identified the population used in this study as being African-American females in grades 4-6. A pre- and post-survey based on a 5-point Likert Scale was the instrument used to collect data from the girls who participated in this study. Descriptive

statistics (number, frequency, and mean) were the methods used to analyze the data collected. The research variables were also identified in this chapter. Chapter IV will list the findings of the study after the researcher completed the methods and procedures described in Chapter III.

CHAPTER IV

FINDINGS

The problem of this study was to determine whether participation in an informal STEM program would positively influence the perceptions of science for eleven African-American girls in grades 4-6. The girls' response ratings before program participation and after program participation were compared and analyzed to see if there was any significance difference in their responses.

Return Rate

Eleven pre- and post-surveys were distributed and received back. To maintain the confidentiality of the BLAST girls, each girl was asked not to write her name on the survey. Instead, they were given a coded ID that relates to science (i.e., Nebula, Star). This was a 100% response rate.

Report of Survey Responses

Question 1 asked girls if they agreed that science was useful to them. Responses for the pre-survey indicated that only one girl strongly agreed with the statement, eight girls agreed, and two were undecided. The pre-survey mean for this statement was 3.90. In the post-survey, seven girls after participation in the Girls-BLAST program strongly agreed with this statement. Three girls agreed with the statement. One girl disagreed. The post-survey mean was 4.45.

Question 2 asked girls if they agreed that they liked the way science was taught at school. Responses for the pre-survey indicated that seven girls strongly agree with the statement and four girls agreed. The pre-survey mean was 4.60. Responses for the post-survey indicated that only one girl strongly agreed with the statement after participation

in the Girls-BLAST program, seven agreed, and two were undecided. The post-survey mean for this statement was 3.54.

Question 3 asked girls if they agreed that they liked doing science experiments. Responses for the pre-survey indicated that two girls strongly agreed with the statement, two agreed, four were undecided, and three disagreed. The pre-survey mean for this statement was 3.27. In the post-survey, nine girls strongly agreed with this after participation in the Girls-BLAST program and two agreed. The post-survey mean was 4.81.

Question 4 asked girls if they agreed that they liked learning about science when they are not in school. Responses for the pre-survey indicated that two girls strongly agreed with the statement, two agreed, four were undecided, and three disagreed. The pre-survey mean for this statement was 3.27. In the post-survey, four girls strongly agreed with this statement after participation in the Girls-BLAST program, four agreed, one was undecided, and one girl disagreed. The post-survey mean was 3.72.

Question 5 asked girls if they agreed that they understood how science applies to their lives. Pre-survey responses indicated that one girl strongly agreed with the statement, five agreed, and five were undecided. The pre-survey mean for this statement was 3.63. In the post-survey, three girls strongly agreed with this statement after participation in the Girls-BLAST program, seven agreed, and one was undecided. The post-survey mean was 4.18.

Question 6 asked the girls if they agreed that they were good science students. Pre-survey responses indicated that four girls strongly agreed with the statement, four agreed, one was undecided, and two disagreed. The pre-survey mean for this statement

was 3.9. In the post-survey, six girls strongly agreed with this statement after participation in the Girls-BLAST program and four agreed. The post-survey mean was 4.36.

Question 7 asked girls if they agreed that science was easy for them to understand. Pre-survey responses indicated that five girls strongly agreed with the statement, four agreed, and one was undecided. The pre-survey mean for this statement was 4.18. In the post-survey, five girls strongly agreed with this statement after participation in the Girls-BLAST program, three agreed, and three were undecided. The post-survey mean was 4.18.

Question 8 asked girls if they agreed that men, not women, should be scientists. Pre-survey responses indicated that zero girls strongly agreed with this statement, two girls agreed, one was undecided, three girls disagreed, and five girls strongly disagreed. The pre-survey mean for this statement was 2.00. In the post-survey, two girls strongly agreed with the statement after participation in the Girls-BLAST, one girl disagreed, and the remaining eight girls strongly disagreed. The post-survey mean was 1.81.

Question 9 asked girls if they agreed that people like them are scientists. Pre-survey responses indicated that two girls agreed with the statement, three were undecided, two disagreed, and four strongly disagreed. The pre-survey mean for this statement was 2.36. In the post-survey, three girls strongly agreed with this statement after participation in the Girls-BLAST program, three agreed, two were undecided, and one strongly disagreed. The post-survey mean was 3.45.

Question 10 asked girls if they agreed that they would like to have a career in science, technology, engineering, or mathematics. Pre-survey responses indicated that

three girls agreed with the statement, six were undecided, and two strongly disagreed. The pre-survey mean for this statement was 3.54. In the post-survey, three girls strongly agreed with this statement after participation in the Girls-BLAST program, three agreed, two were undecided, and one strongly disagreed. The post-survey mean was 3.45.

Question 11 asked girls if they agreed that they are interested in working at a science center teaching people about science. Pre-survey responses indicated that one girl strongly agreed with this statement, one agreed, five were undecided, one disagreed, and one strongly disagreed. The pre-survey mean for this statement was 2.45. In the post-survey, two girls strongly agreed with this statement after participation in the Girls-BLAST program, two agreed, six were undecided, and two disagreed. The post-survey mean was 4.09.

Question 12 asked girls if they agreed that they were interested in working at a company designing toys. Pre-survey responses indicated that one girl agreed with the statement, two agreed, two were undecided, one disagreed, and five strongly disagreed. The pre-survey mean for this statement was 2.36. In the post-survey, three girls strongly agreed with this statement after participation in the Girls-BLAST program, seven agreed, and one disagreed. The post-survey mean was 3.9.

Question 13 asked girls if they agreed that they were interested in working at a theme park designing rides. Pre-survey responses indicated that two girls strongly agreed, four were undecided, two disagreed, and three strongly disagreed. The pre-survey mean for this statement was 2.63. In the post-survey, three girls strongly agreed with this statement after participation in the Girls-BLAST program, four agreed, and four were undecided. The post-survey mean was 3.63.

Question 14 was the last Likert scale statement and asked girls if they agreed that they were interested in working for a company that designs food products. Pre-survey responses indicated that three girls were undecided about this statement, two disagreed, and five strongly disagreed. The pre-survey mean for this statement was 1.63. In the post-survey, five girls strongly agreed with this statement after participation in the Girls-BLAST program and six were undecided. The post-survey mean was 3.45. See Table 4.1, 4.2 and 4.3 for a summary of the findings.

Table 4.1. Frequency of student responses to pre-survey questions

Survey Statement	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
1. Science is useful to me.	1	8	2	0	0
2. I like the way science is taught at school.	7	4	0	0	0
3. I like doing science experiments.	2	2	4	3	0
4. I like learning about science when I am not in school.	2	2	4	3	0
5. I understand how science applies to my life.	1	5	5	0	0
6. I am a good science student.	4	4	1	2	0
7. Science is easy for me to understand.	5	4	1	1	0
8. I think men not women should be scientist.	0	2	1	3	5
9. People like me are scientists.	0	2	3	2	4
10. I would like to have a career in science, mathematics, technology or engineering.	3	0	6	0	2
11. I am interested in working at a science center teaching people about science.	1	1	5	1	1

12. I am interested in working at a toy company designing toys.	1	2	2	1	5
13. I am interested in working at a theme park designing rides.	2	0	4	2	3
14. I am interested in working at a food company designing food products.	0	0	3	2	5

Table 4.2. Frequency of student responses to post-survey questions

Survey Statement	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
1. Science is useful to me.	7	3	0	1	0
2. I like the way science is taught at school.	1	7	2	0	0
3. I like doing science experiments.	9	2	0	0	0
4. I like learning about science when I am not in school.	4	4	1	1	0
5. I understand how science applies to my life.	3	7	1	0	0
6. I am a good science student.	6	4	0	1	0
7. Science is easy for me to understand.	5	3	3	0	0
8. I think men not women should be scientist.	2	0	0	1	8
9. People like me are scientists.	3	3	2	2	1
10. I would like to have a career in science, mathematics, technology or engineering.	2	2	6	1	0
11. I am interested in working at a science center teaching people about science.	3	7	0	1	0
12. I am interested in working at a toy company designing toys.	3	4	4	0	0
13. I am interested in	1	5	5	0	0

working at a theme park designing rides.					
14. I am interested in working at a food company designing food products.	0	5	6	0	0

Table 4.3. Mean responses to pre- and post-survey questions

Survey Statement	Pre-Survey Mean Rating	Post-Survey Mean Rating	Difference in Mean Scores
1. Science is useful to me.	3.9	4.45	.6
2. I like the way science is taught at school.	4.6	3.54	-1.06
3. I like doing science experiments.	3.27	4.81	1.54
4. I like learning about science when I am not in school.	3.27	3.72	0
5. I understand how science applies to my life.	3.63	4.18	.55
6. I am a good science student.	3.9	4.36	.46
7. Science is easy for me to understand.	4.18	4.18	0
8. I think men not women should be scientist.	2	1.81	-.19
9. People like me are scientists.	2.36	3.45	1.09
10. I would like to have a career in science, mathematics, technology or engineering.	3.54	3.45	-.09
11. I am interested in working at a science center teaching people about science.	2.45	4.09	1.64
12. I am interested in working at a toy company designing toys.	2.36	3.9	1.54
13. I am interested in working at a theme park designing rides.	2.63	3.63	1.00
14. I am interested in working at a food company designing food products.	1.63	3.45	1.82

Findings for Open-Ended Statements

Both the pre-and post-surveys had two open-ended statements at the end for participants to write their own responses. In the pre-survey, girls chose to participate in the program for the following reasons: two girls replied that they loved science, two girls replied they thought it would be fun, two were interested in science, one girl wanted to continue to learn, one thought it would teach her about science in life, and one girl had no comment. In replies to the statement of how the program would benefit them: five girls replied that they wanted to learn more about science, three thought it would teach them about science in life, and one thought it would help her in science class next year, one thought it would allow her to help someone if they needed help, and one girl had no comment.

In the open-ended post-survey question asking them to complete the statement "the best thing about the BLAST program was," six girls replied "everything," one girl replied "making ice cream," one girl replied "making cola," one girl replied "making a simple circuit in a toy," one girl replied "making a rollercoaster," and one replied "it really helped me learn more about science." If they could change anything about the program, nine girls would not change anything, one girl replied that she would start a science club, and one girl replied "get more kids interested in it."

Summary

This chapter included data collected from pre- and post-program surveys that girls took before and after program participation. Table 4.3 showed the positive and negative differences between mean scores for each question. Overall, the post-test scores were higher than the pre-test scores indicating that the program stimulated improvement in the

girls level of agreement with 11 out of the 14 questions. Two statements showed slight negative scores, but these actually indicated an improved attitude because the statements were initially negative (see Questions 2 and 8). Statement 10, about liking a STEM career, showed a slight negative result (-.09). The greatest positive changes were shown in Questions 11 and 14, which both pointed toward certain STEM careers. Questions 3 and 12 scored the same positive difference (1.54). They dealt with liking to do science experiments and having an interest in designing toys. Two open-ended survey questions were also asked in the pre-and post-surveys. The findings of this study will be interpreted in Chapter V, conclusions will be drawn, and recommendations will be made for similar research studies involving STEM programs for African-American girls.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter will summarize the research by reviewing the problem of the study, research goals, and the significance of the study. The limitations that were a part of this study will be explained. The instrument used to collect and evaluate the study is explained. A conclusion will be drawn based on the study findings and recommendations made for future studies.

Summary

The problem of this study was to determine whether participation in an informal STEM program would positively influence the perceptions of science for eleven African-American girls in grades 4-6. To guide this study, the goals were to answer the following questions: (1) Will the girls' enthusiasm toward science increase if they are presented informal science lessons in a non-school setting? (2) Will the girls' confidence and ability toward science increase if they are presented informal science lessons in a non-school setting? (3) Will the girls' have an interest in pursuing a STEM career if they are presented informal science lessons in a non-school setting?

This study was significant because African-American females are underrepresented in Science, Technology, Engineering, and Mathematics (STEM) careers. STEM careers are currently the fastest growing career fields in the world. However, the United States is not producing enough U.S. citizens who obtain these careers. African-American female citizens make up the lowest percentage of United States STEM workers. They comprise only 2% of the science and technology workforce of 4.9 million (National Science Foundation, 2007).

Early intervention programs have been designed and implemented to expose young minority girls to STEM education and careers at an early age. The programs have been offered in formal school settings and informal settings (museums, aquariums, community centers, etc.). The expected outcome of these programs involved increasing girls' awareness, confidence, ability, and interest in STEM education and careers.

This study was limited to eleven African-American girls in grades 4-6 who attended public school systems in Richmond, Virginia, or the surrounding counties of Henrico and Chesterfield. Girls were presented with hands-on lessons focusing on toy design, food technology, and theme park engineering. To evaluate girls' perceptions of the program before and after participation, a pre- and post-survey was used. Surveys consisted of 14 items and two open-ended statements. Survey statements questioned girls' enthusiasm, confidence, ability, and interest in science and STEM careers. The researcher used a five-point Likert scale to rate participants' responses to each survey question. Ratings were: 5 for strongly agree, 4 for agree, 3 for undecided, 2 for disagree, and 1 for strongly disagree.

Conclusions

The problem of the study was to positively influence the perceptions of the participants toward science. Research Question 1 addressed changes in girls' enthusiasm toward science. Data from the first four statements on the pre- and post-test surveys showed a 47% increase in their liking to do science experiments, a 42% decrease in their liking the way science is taught at school, a 15% increase in their agreement that science is useful to them, and no change in their agreement that they like learning about science

when they are not in school. Overall, the data showed that the program did positively influence the girls' enthusiasm toward science.

Research Question 2 addressed confidence and ability toward science. The data showed that overall, the girls' confidence and ability improved. Questions 5-9 showed an improvement in understanding how science applies to their lives (15%), an improvement in their agreement that they are good science students (12%), no change in their agreement that science is easy to understand, and a 10% decrease in their agreement that "men not women should be scientists." Their scores increased by 46% when asked if they agree that "people like me are scientists." These data showed an increase in their confidence and ability.

Research Question 3 addressed interest in pursuing a STEM career. There was a 3% decrease in their agreement that they would like to have a career in the STEM topics, but a 67% increase in their agreement that they are interested in working in a science center teaching people about science. Their interest in working at a toy company designing toys increased by 65%. They showed a 38% increase in interest in working at a theme park designing rides, and 117% increase in their interest in working at a food company designing food products.

Although the sample size was small, the researcher was encouraged by the positive trend in the scores over all three research questions. The girls seemed to identify positively with the facilitator who worked as a teacher at a science center. They particularly liked the activity with food which related so closely with their life experiences. These results may be significant to an educator who seeks "programs that work." Researchers can see that, at a young age, even a small project can have positive

effects on the participants. Perhaps this study can join a body of research that leads to solutions to the problems of low participation in the STEM workforce of African–American women.

Recommendations

To design and implement a STEM program that will have a positive impact on African-American girls, the curriculum activities, the method of presentation, and the environment for implementation of the activities should be selected wisely. Clearly, there should be female role models for the girls to identify. The curriculum that is selected is extremely important when implementing a STEM program that inspires. The curriculum should be fun and engaging. All of the topics of the lessons presented in this study focused on things that girls could relate to such as toys, theme park rides, and food. It is advised that for future studies the researcher choose STEM topics and careers that would encourage interest and build upon students' experiences involving the topic. When researching lesson topics, researchers should examine the latest trends in STEM education and careers. This information should be incorporated into lessons to inform girls of future careers.

The environment where the program takes place is important for inspiring and empowering young girls. Participants should have a place in which they feel comfortable to question, explore, and discover science. They should not feel like they are in a strict, rigid setting when they are exploring science. A preferable setting would be an informal environment like an after-school program or summer camp program that takes place in a community center, museum, or aquarium. The Salvation Army Boys & Girls Club where

this study took place was an informal community setting where the girls could feel comfortable and less pressured about learning.

Role models should be provided for girls. These role models should be females and minorities. It is extremely important that girls become aware of females of color that have STEM careers. If a project is focusing on a particular race, role models of that race in STEM careers should be presented to girls, in addition to other minority females. It is imperative that girls have role models that they can identify. Role models for the girls can be incorporated in the program through invited presentations, visits to workplaces, pictures, books, the internet, or correspondence with a role model through email or video-streaming.

There are many research studies involving girls and science, however there are limited research studies focusing entirely on African-American girls. This information should provide additional supporting evidence of what is needed to positively change the perceptions of young African-American girls of science and STEM careers. The positive impact was immediate. However this study cannot indicate whether it will be lasting. To find out long-term effects that a program like Girls-BLAST will have on girls' perceptions of science and STEM careers, longitudinal studies are suggested.

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Appendix A

Girls-BLAST Program

Pre-Survey

Science Code Name:_____

Race: _____ Grade Level: _____ Age_____

Please rate each sentence below that best describes how you feel.

	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
1. Science is useful to me.					
2. I like the way science is taught at school.					
3. I like doing science experiments.					
4. I like learning about science when I am not in school.					
5. I understand how science applies to my life.					
6. I am a good science student.					
7. Science is easy for me to understand.					
8. I think men, not women should be scientists.					
9. People like me are scientists.					
10. I would like to have a career in science, math, technology or engineering.					
11. I am interested in working at a science center teaching people about science.					
12. I am interested in working at a toy company designing toys.					
13. I am interested in working at a theme park designing rides.					
14. I am interested in working at a food company designing food products.					

Complete the sentences below by writing how you feel about the Girls BLAST program

(Use the back of this survey if extra space is needed to write your response)

1. I chose to participate in this program because _____
2. I think this program will benefit me by:_____

Appendix B

Girls-BLAST Program

Post-Survey

Science Code Name: _____

Race: _____ Grade Level: _____ Age_____

Please rate each sentence below that best describes how you feel.

	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
1. Science is useful to me.					
2. I like the way science is taught at school.					
3. I like doing science experiments.					
4. I like learning about science when I am not in school.					
5. I understand how science applies to my life.					
6. I am a good science student.					
7. Science is easy for me to understand.					
8. I think men, not women should be scientists.					
9. People like me are scientists.					
10. I would like to have a career in science, math, technology or engineering.					
11. I am interested in working at a science center teaching people about science.					
12. I am interested in working at a toy company designing toys.					
13. I am interested in working at a theme park designing rides.					
14. I am interested in working at a food company designing food products.					

Complete the sentences below by writing how you feel about the Girls BLAST program

(Use the back of this survey if extra space is needed to write your response)

1. The best thing about the BLAST program was_____
2. If I could change anything about the BLAST program, it would be_____

Appendix C

Girls-BLAST Program Curriculum Schedule

DAY	Topic To Explore	Career Focus Activities
Day 1	Toy Design	Career Focus: Toy Designer Activities: Girls play with a variety of toys; discuss how they work and what age group it was marketed to. Girls learn how to identify toy into categories (board games, get out and play toys, learning toys). Girls explore the science behind Operation game. Girls are given a variety of tools and safety gear to take apart toys of their choice to formulate their ideas of how they think it works. Girls are given the opportunity take apart a toy of their choice to find out how it works. The girls finish the toy lesson by designing and marketing their own toy.
Day 2	Toy Design Continued	
Day 3	Food Technology	Career Focus: Food Technologist Activities: Girls make their own formula for cola and ice cream. They dissect a microwave popcorn package to find out how it was designer. They make a package that will keep a baked potato warm (70 degrees or higher) for 10 minutes.
Day 4	Theme Park Engineering	Career Focus: Theme Park Engineer Activities: Girls explore roller coaster design and design their own rollercoaster.
Day 5	Theme Park Engineering Continued	